How to measure field-of-study mismatch? A comparative analysis of the different methods[1]

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Abstract

We compare the different methods used to measure field-of-study mismatch. A first part reviews the literature, detailing and discussing the different approaches. A second part uses a data-set allowing one to investigate whether these different approaches result in differences with respect to the incidence and determinants of field-of-study mismatch. Since substantial differences do indeed exist, even among variants of similar approaches, we conclude that empirical results should be interpreted with caution. While making several recommendations concerning the measurement of field-of-study mismatch, we also call for more focused research on the validity and reliability of field-of-study mismatch measures.

Key words: mismatch, horizontal mismatch, measurement, field of study, underemployment, job analysis
JEL codes: I26, J24

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INTRODUCTION

The past decades witnessed a rapid expansion of tertiary education. However, this expansion was not evenly spread over all fields of study. In 2011, one of the most popular fields of study among tertiary education students in Europe was Social sciences, Business and Law (OECD, 2012). The second largest group of students opted for Humanities, Arts and Education. Fields of study such as Sciences and Engineering, Manufacturing and Construction were less popular. Qualifying the general trend in this way is important, because studies have shown that labour market outcomes differ amongst fields of study. Indeed, monetary returns as well as unemployment rates diverge substantially amongst fields of study with returns being higher for fields of study such as Health, Engineering, Business and Science relative to Arts and Humanities (Finnie & Frenette, 2003; McGuinness, 2003; Arcidiacono, 2004).

Next to realized wages and overall employment chances, an important indicator to assess the labour market success of graduates is whether they are employed in jobs matching their education as well vertically (i.e. whether one is not overeducated or undereducated for the job) as horizontally (i.e. whether the content of the job fits with the specialization of the degree). The latter dimension is particularly relevant when focusing on the labour market chances of graduates from different fields of study. Robst (2007a), Wolbers (2003) and Verhaest, Sellami and van der Velden (2017) found that Humanities and Arts graduates are relatively more likely to have a mismatch between their field of study and the content of their job. A number of studies showed that this type of match matters for earnings and job satisfaction, with those combining field-of-study mismatch with overeducation facing the most adverse effects (Robst, 2007a; Béduwé & Giret, 2011; Støren & Arnesen, 2011). If so, lower monetary and psychological rewards for particular degrees might be explained (at least partly) through a higher likelihood to be mismatched either vertically or horizontally or both.

Given the likely importance of field-of-study mismatch in accounting for differences in other labour market outcomes, the question arises whether and to what extent using different methods to measure this kind of mismatch affects the reported incidence as well as its determinants. With respect to overeducation, several literature reviews have been conducted providing useful insights into the advantages and disadvantages of each method (Groot & Maassen van den Brink, 2000a; Hartog, 2000; Sloane, 2003; McGuinness, 2006; Leuven & Oosterbeek, 2011). Further, single-dataset studies have shown that different methods do indeed result in differences in the incidence of overeducation (Cohn & Khan, 1995; van der Velden & van Smoorenburg, 1999; Battu *et al.*, 2000; Groot & Maassen van den Brink, 2000b; Verhaest & Omey, 2006). As regards the determinants of overeducation,

the evidence is somewhat more nuanced. Irrespective of the measure being used, studies usually indicate a number broadly defined mechanisms such as the quality of human capital, the field of study or search and spatial constrains to matter (McGuinness, 2006). But as soon as the focus is on more specific variables and policies related to these mechanisms, as is usually the case in more applied research, conclusions are often much more sensitive to the measure being used (McGoldrick & Robst, 1996; Giret & Hatot, 2001; Verhaest & Omey, 2010; Ramos, 2014). Whether this is also the case regarding field-of-study mismatch remains an unexploited area.[5]

This paper aims at filling two research gaps. First, we conduct a detailed review of the literature on field-of-study mismatch, focusing on the way the different contributions operationalize the concept. Second, using a rich data-set which allow to construct the different measures used in the literature, we examine to what extent the measured incidence and determinants of field-of-study mismatch is influenced by the method used.

The paper is structured as follows. A first section provides some conceptual and terminological clarifications. A second section surveys the literature. It explains in detail how field-of-study mismatch has been measured until now and discusses the advantages and weaknesses of each approach. A third section presents an additional empirical analysis, comparing the result of applying the different measures based on the same dataset. A final section discusses the research implications of the review and the analysis.

CONCEPTUAL CLARIFICATIONS

There exists a substantial literature focusing on *educational mismatch*. Educational mismatch refers to an imperfect match between a graduates' educational attainment and the educational requirements of his or her job. Until recently, the bulk of this literature focused on overeducation, i.e. the situation of individuals working in a job with their educational level exceeding the level required for doing the job well (McGuinness, 2006). Nonetheless, several studies have also focused on the mechanisms and the effects of mismatch in terms of field of study. Initially, the topic attracted the attention of sociologists, such as Solga and Konietzka (1999), Witte and Kalleberg (1995) or Wolbers (2003). More recently, the topic has also gained attention by economists, with in particular the study by Robst (2007a) being influential. Congruent with the definition of overeducation, these studies usually conceptualize field-of-study mismatch as a mismatch between the attained field of study of the individual and the field of study required for doing the job well. While the term field-of-study mismatch is most used, several other terms have

[5] Another unexploited area is the extent to which different measures of horizontal mismatch generate differently estimated effects on outcome variables such as wages or job satisfaction. With respect to wages, this question is partly addressed in a follow-up paper (Sellami et al., 2017).

been used for what basically comes down to the same concept. For example, Støren and Arnesen (2011) and Béduwé and Giret (2011) refer to horizontal (educational) mismatch. Others call this mismatch in terms of type of schooling (Robst, 2007a, 2007b), education-job mismatch (Boudarbat & Chernoff, 2012) or field of education-occupation match (Nordin, Persson & Rooth, 2010).

The definition of field-of-study mismatch requires to clarify what is meant with the *required field of study*. This may be interpreted as the field delivering the cluster of knowledge and skills that is necessary to execute the job. Yet, it is unlikely to be efficient to produce all the required knowledge and skills by means of formal education; some required skills may simply be more efficiently acquired through other types of skill acquisition such as on-the-job training. Hence, since an optimal balance may exist between different types of skill acquisition activities, we define the required field of study for a job as the one delivering the optimal preparation for the job. A program is not (only) optimal because it may be the most efficient way to acquire some of the skills required for the job, but (even more so) because it facilitates further on-the-job learning for required skills that are less easily acquired through more formal learning.

Conceiving the required field of study as the most efficient one also implies that *requirements* may be assessed either *from a social or a private point of view*, with the latter further being defined either from the worker's perspective or from the employer's perspective. Unless otherwise stated, we focus on mismatch from a social point of view throughout this paper. While mismatch from the point of view of the worker or the employer may be interesting research topics, such focus neglects the role of public interventions in education. For instance, due to regulations or lack of subsidization, the educational system may not offer the programs that deliver the socially-optimal preparation for particular types of occupations. From a private point of view, workers in these occupations may nevertheless have an educational match if they participated in the best-available or most generously subsidized program. Given that public spending on education is substantial in all developed countries, looking at privately-defined mismatches may thus only deliver a very partial view on the extent to which there is truly a mismatch problem for society as a whole. This is even more so the case when looking at mismatch from the perspective of the employer given their negligible role in paying for the formal education of their workers.

By defining the required education as the socially optimal education to acquire the skills needed for doing the job, we also differentiate from *hiring and entry requirements*. For many reasons, entry and hiring requirements may differ from the requirements needed for being optimally prepared for the job. Such divergence may, amongst others, result from labour market imbalances, when employers set less strict hiring requirements in response to an insufficient supply of graduates with the optimal field of study. But the opposite may also exist, with hiring or entry requirements being more strict than the requirements for being optimally prepared for the occupation. This may,

for instance, occur in the case of so-called licensed occupations, when individuals need, by law or regulation, a certificate of a particular program or education to enter into these occupations. Although the main argument in favour of these regulations is to guarantee a sufficient quality of the product or service, bureaucratic inertia or protectionist forces may cause these entry regulations to be too strict from the perspective of what is needed for doing the job appropriately (Kleiner, 2000).

Educational mismatches should not necessarily coincide with *skill mismatches* either. The latter can be defined as working in a job where the required skills of the job do not match the acquired skills (Allen & van der Velden, 2001). A match in terms of formal education is not a necessary nor a sufficient condition for skill utilization. For instance, a graduate having the optimal field of study for a job may nevertheless be underskilled at the start if it is optimal to acquire part of the required skills through further informal learning. Despite this conceptual distinction, educational and skill mismatches are frequently used as equivalent terms. Relying on educational mismatch measures as proxies for skill mismatches is often a matter of pragmatism: direct data on attained and required skills are often not available to the researchers. However, even individuals with similar qualifications and reported experiences may be very heterogeneous in skills. For example, a highly educated individual working in a less-demanding job may not underutilize his skills because of low innate talents and abilities or because of having experienced skills depreciation. A growing literature deals with both types of mismatches as being different concepts, in particular by focusing on the relation between skill mismatches and vertical educational mismatch (see Allen & van der Velden, 2001; Green & McIntosh, 2007; Mavromaras, McGuinness, O'Leary, Sloane & Wei, 2013). These studies confirm that overeducation does not necessarily imply overskilling (and vice versa) and that both types of mismatches may have a distinct effect on wages and/or job satisfaction.

To measure educational mismatches, three different methods have been used in the literature: worker self-assessments, job analysis and realized matches. These measurement methods were originally developed in the overeducation literature (Hartog, 2000). The *worker self-assessment method* (WA) is based on the opinion of individuals assessing whether their education matches the required education of their job. A direct way (DWA) to do so is, for instance, by asking individuals whether they feel overeducated or not; an indirectly way (IWA) is, for instance, by asking them which educational level is needed to get or to perform their job. The *job analysis* method (JA) is a based on evaluations by job analysts, who define the required education for jobs relying on occupational classification methods. The *realized matches* method (RM) derives the required educational level from the actual distribution of educational levels within occupations. For instance, to measure the required level of education relying on this method, the mean or the modal educational level within an occupation has been used. In the context of over- and undereducation, each of these methods have extensively been reviewed and discussed in the literature.

For field-of-study mismatch, similar methods have been used but an extensive review and analysis of these different methods is not present.

LITERATURE REVIEW

Table 1 presents an overview of the studies on field-of-study mismatch. For each study, it specifies its measurement approach and the resulting incidences of field-of-study mismatch. Even a brief look at the table shows substantial differences in the incidence of mismatch as well across the different studies as within each of the measurement approaches. Overall, the incidence of measured field-of-study mismatch ranges from 5% to 59%. Among studies using WA (20 out of 27 studies), the pioneering study of Witte and Kalleberg (1995) is an outlier with an incidence that lies between 39% and 51%. For other studies using WA, we note incidences between 5% and 35%. The average incidence based on this method across all studies is 21%. In the case of JA (6 studies), we find substantially higher incidences with an average of 35%. The only study based on RM finds an incidence of about 40%.

These results are somewhat different from those found in literature reviews on overeducation. Groot and Maassen van den Brink (2000a) concluded that RM delivers on average lower estimates of the incidence of overeducation. Regarding the other methods, they didn't find evidence for systematic differences. Of course, the measurement approach may not be the only explanation for the differences across studies. Differences in sample composition also may play a role. Further, within each of the approaches, substantial differences exist with respect to the specific way the measure used is operationalized. In the remainder of this section, we discuss in more detail how these different methods are applied in practice and discuss their strengths and weaknesses.

Worker Self-Assessments (WA)

The WA method produces a measure of mismatch based on the view of the job holder about the appropriate educational requirement for his or her job. In other words, the individual worker assesses whether he or she has the appropriate field of study to perform the job. In theory, the WA measure can be constructed either directly or indirectly. In the case of the direct method (DWA), individuals are asked to what extent their field of study is related with their job. Also an indirect method (IWA) may be possible, by asking individuals about the field of study that was required to get or to perform their job. The comparison of the attained with the required field of study is then made by the researcher. In the overeducation literature, the IWA approach is much more prominent than the DWA approach (Groot & Maassen van den Brink, 2000a). However, as far as we know, none of the published studies on field-of-study mismatch have used the IWA method yet.

TABLE 1 – RESEARCH ON THE INCIDENCE OF HORIZONTAL MISMATCH

Study	Subjects	Country	Measure	Question and response categories (WA) / classification system (JA – RM)	Incidence
Allen & de Weert (2007)	Graduates from tertiary education	Spain, Germany, Netherlands, UK and Japan	DWA	Respondents were asked to indicate the extent to which the degree course is related to the job. Five categories were provided: (1) My field of study is the only possible/ by far the best field, (2) Some other fields could prepare for the area of work as well, (3) Another field would have been more useful, (4) Field of study does not matter very much, (5) Higher education studies are not all related to my area of work. The first two categories were defined as match, the other three categories indicate work that was clearly outside one's field.	14.1%[6]
Allen & van der Velden (2001)	Graduates from tertiary education	Netherlands	DWA	Which field of education is most appropriate for the job? Five categories were provided: (1) Only my own field of education, (2) My own or a related field, (3) A completely different field of education, (4) For this job no specific field is required, (5) For this job no specific field (yet) exists. The first two categories were defined as match, the other three categories indicate work that was clearly outside one's field.	20.0%
Béduwé & Giret (2011)	Gaduates from tertiary education	France	JA	Using normative correspondence tables, one for educational level and one for the specialty	59%
Boudarbat & Chernoff (2012)	Graduates from university	Canada	DWA	Respondents were asked to indicate whether their job is closely, somewhat or not related to education. The category closely related to education is match, other categories were defined as otherwise	35.1%
Di Pietro & Urwin (2006)	Graduates from university	Italy	DWA	Those in graduated jobs were asked whether (1) any university degree was a formal requirement or (2) a university degree in a specific subject or subject area was a formal requirement.	4.6%

[6] The incidence of horizontal mismatch has been recalculated

				If any university degree was a formal requirement then the individual has a horizontal mismatch.	
Domadenik, Farcnik & Pastore (2013)	Graduates from tertiary education	Slovenia	JA	International Standard Classification of Education 2008 and a three digit code.	29.1% (2007) 29.5% (2008) 44.1% (2009)
Grayson (2004)	Graduates from university	USA (York University)	DWA	How closely is your job related to your undergraduate education at York? Is it closely related, somewhat related, or not related at all?	n.a.
Heijke, Meng & Ris (2003)	Graduates from tertiary education	Netherlands	DWA	Respondents were asked about the relationship between their field of study and his or her area of work. Respondents that indicated that neither the own field of study nor a related field of study would have been the best preparation are defined as having a horizontal mismatch.	18%
Katz-Gerro & Yaish (2003)	Graduates from tertiary education	Israel	JA	Israeli Central Bureau of Statistics and used a three digit code to define the occupational groups	37.1%[2]
Kelly, O'Connell & Smyth (2010)	Graduates from tertiary education	Ireland	DWA	Respondents were asked how matched they felt their field of study was to their current job	27%
Kim, Ahn & Kim (2016)	Graduates from tertiary education	Korea	DWA	Respondents could indicate whether their field of study matched or was completely (partially) different from what their job normally required. If respondents indicate their field of study was completely different from what is required, they were defined as horizontal mismatched.	18.4%
Klein (2011)	Graduates from tertiary education	Germany	DWA	Respondents were asked whether they are adequately employed according their field of study. They could answer this question with a five point scale, where (1) yes definitely, (5) definitely not. The last three categories indicate a job mismatch	35.2%
Kucel & Vilalta-Bufi (2010)	Graduates from tertiary education	Spain	DWA	Which field of study is most appropriate for the job? They could choose between four categories: (1) Strictly own field of education, (2) My own or a related field, (3) A completely different field of education, (4) No particular field required.	18%

				Respondents have a match if they answered with the first two categories, otherwise a mismatch.	
Kucel, Vilalta-Bufi & Róbert (2011)	Graduates from tertiary education	East and Central Europe	DWA	Which field of study is most appropriate for the job? (cf. Kucel and Vilalta- Bufi (2010) for the used categories)	13% - 16%
Little & Arthur (2010)	Graduates from tertiary education	11 European Countries	DWA	Which field of study is most appropriate for the job? (cf. Kucel and Vilalta- Bufi (2010) for the used categories)	6% - 13% (field of study not related)
Nieto, Matano & Ramos (2015)	Native and immigrant workers between 15 and 64 years old	15 European Union Countries	RM	Used information from the Adult Education Survey	39%-40%
Nordin, Persson & Rooth (2010)	Graduates from tertiary education	Sweden	JA	For education data they used the SUN2000 Classification. For the occupational data they used the SSYK classification and used a three digit code to defined the occupational groups	17%-23%
Robst (2007a)	Graduates from tertiary education	USA	DWA	To what extent was your work related to your highest degree field? Was it closely related, somewhat related, or not related? Individuals that worked in a job that somewhat related were defined partially mismatched, working in a job that is not related are completely mismatched	20.1%
Robst (2007b)	Graduates from tertiary education	USA	DWA	To what extent was your work related to your highest degree field? Was it closely related, somewhat related, or not related? (cf Robst (2007a) for definition)	19.1%-21.4%
Robst (2008)	Graduates from tertiary education	USA	DWA	To what extent was your work related to your highest degree field? Was it closely related, somewhat related, or not related? (cf Robst (2007a) for definition)	n.a.
Solga & Konietzka (1999)	Graduates from several birth cohorts	East and West Germany	JA	International Standard Classification of Occupations 1968(ISCO) and use a three digit code	23%-27% (W. Germ.) 25%-26% (E. Germ.)

Støren & Arnesen (2011)	Graduates from tertiary education	Thirteen OECD Countries	DWA	Which field of study is most appropriate for the job? Individuals could provide four answers: (1) Strictly own field of education, (2) My own or a related field, (3) A completely different field of education , (4) No particular field required	15%[7]
Verhaest, Sellami & van der Velden (2017)	Graduates from tertiary education	17 European countries and Japan	DWA	Which field of study is most appropriate for the job? (cf. Støren and Arnesen (2011) for the categories)	10.4%
Verhaest, Van Trier & Sellami (2011)	Graduates from tertiary education	Belgium (Flanders)	DWA	Was the content of your first job in line with your education? Categories were: (1) completely, (2) somewhat in line (3) not at all in line.	16.1%
Witte & Kalleberg (1995)	Panel study of households of seven waves (1984-1990)	Germany	DWA	Respondents were asked whether they have been trained for their occupation. Categories were 'yes', 'no', 'currently in education' or 'have not been trained for an occupation'.	39%-51%
Wolbers (2003)	School-leavers which are 15-35 years old and left initial education within the past five or ten years.	Europe	JA	International Standard Classification of Occupations 1988(ISCO) and use a three digit code	n.a.
Zhu (2014)	Graduates from tertiary education	China	DWA	Respondents were asked about their current job status. They could answer with (1) 'I am now employed, and the job is related to my major' or (2) I am now employed, but the job is unrelated to my major'. The first two categories were defined as match, the other category as mismatch	28.2%

[7] The incidence of horizontal mismatch has been recalculated

Witte and Kalleberg (1995) were among the first to use WA within the context of field-of-study mismatch. They asked individuals whether they have been trained for their occupation with as possible answers: 'yes', 'no', 'currently in education' or 'have not been trained for an occupation'. Only if individuals answered 'yes', they were assumed to have a match. They found that 61% (49%) of the women (men) were employed in a job for which they had a match. However, we have to bear in mind that the operationalization of Witte and Kalleberg might also capture overeducation since individuals could interpret 'having been trained for the occupation' as having both the appropriate educational level and the appropriate field of study. This may (partly) explain why the incidence in their study is substantially higher than in other studies relying on WA.

Whereas Witte and Kalleberg distinguished two broad categories only, other studies allowed for the possibility of a third category. Robst (2007a) relied on a survey question to US college graduates regarding the extent to which their work was related with the field of their highest degree. Respondents could answer that their work was 'closely related', 'somewhat related' or 'not related' to their highest degree field. Robst did assign those with a somewhat related job to a third category of 'partial mismatch'. Alternatively, some studies rather rely on a Likert scale. Also on the basis of this approach, a decision has to be made about the classification of the middle categories. In the study of Klein (2011), for instance, individuals were asked whether they are adequately employed according to their field of study. They could answer on a five point scale, from yes definitely (1) to definitely not (5). The last three categories where defined as field-of-study mismatch.

Evidently, the decision to classify the middle category as match or mismatch will affect the measured incidence of mismatch. However, this decision is more than just a decision about where one wants to put the cut-off point. Depending on the theoretical definition that is applied regarding the required field of study, a different decision may be made. In our framework, the required field of study is defined as the optimal field of study. For some occupations, a more general field of study may be more optimal than a rather specific one. Hence, even those who answer that their field of study is somewhat related to their job (cf. Robst, 2007a) may have the most appropriate field of study according to our definition. One could, therefore, argue that it is appropriate to group those with a 'somewhat related field' and those with a 'closely related field' together instead of keeping them as a separate category or merging them with the 'not related' category. An additional argument for classifying them as having a match is the positive connotation that is associated with the wording 'somewhat related field'. In the empirical analysis of this paper, we will investigate how the decision to do so may affect the results.

While most of the aforementioned studies ask respondents whether their work is related with their field of study (e.g. Robst, 2007a), other studies reverse the question and ask respondents whether their field of study was most appropriate for the job. The studies of Kucel and Vilalta-Bufi (2010), Kucel *et al.* (2011), Little and Arthur (2010), Støren and Arnesen (2011) and Verhaest *et al.* (2017) all use the so-called REFLEX data. Respondents got the

following question: "which field of study is most appropriate for the job?". The individuals could provide four different answers: (1) Strictly own field of education, (2) My own or a related field, (3) A completely different field of education and (4) No particular field required. Most of these studies consider individuals as having a mismatch if they reported that 'no particular field was required'. Only Little and Arthur (2010) analysed this category as a separate category.

Several arguments can be put forward in favour of considering the 'no particular field of study was required' answer as indicating a field-of-study mismatch. First of all, individuals providing this answer may be employed in jobs requiring rather specific skills within a domain for which no existing or publicly subsidised educational program prepares. If organizing such a program would be cost-effective, one may consider these individuals as mismatched from a social point of view.[8] Second, these individuals may also be employed in either low-skilled jobs requiring only basic skills without specialization or in high-skilled jobs requiring mostly general skills or a broad range of specific skills and knowledge, such as for managers. In the latter case, a program focusing purely on general skills or on a broad range of specific skills may offer a socially more efficient pathway than a more specific and disciplinary-focused program. If so, also these individuals could be defined as being mismatched. However, the most efficient pathway for occupations such as managers may just as well be any more specific program followed by more intensive on-the-job learning. In this case, the specific program may to a large extent serve as a signal for ability. Such a situation should not be considered to be a mismatch in terms of field of study. Note that these arguments do not necessarily apply to mismatch being assessed from a private point of view. For instance, from the perspective of an employer who doesn't pay for the formal education of his employees, it may not matter much whether a graduate that is employed in a low-skilled job either has a degree in physics or in sociology.

While the aforementioned arguments regarding the classification of the 'no required field' category are for WA measures derived from survey questions on the education required to do the job, the researcher's assessment may differ when based on questions about hiring requirements. Some employers may not set strict requirements in their vacancy postings in order to attract a sufficient number of candidates. Still, it is likely that these employers prefer those having the most appropriate field of study and, as a consequence, that as least part of those answering that "no field was required" do have the most appropriate field for doing the job. As a consequence, there will be a the risk of overestimating the incidence of mismatch by defining the "no field was required" category as mismatch. In our empirical analysis, we will therefore test to what extent the decision to classify those answering that 'no particular field of study was required' either as a mismatch or as a match affects the results.

[8] Interestingly, the study of Allen and van der Velden (2001) relied on a dataset that considered a fifth category that was labeled 'for this job no specific field (yet) exists'. In line with our arguments, they classified this answer as mismatch.

Job Analysis (JA)

Another set of contributions relies on JA. In this case, job analysts define the education required for each occupation. In the overeducation literature this approach is quite common, whereas it has been used less frequently for the measurement of field-of-study mismatch (cf. Table 1).

Solga and Konietzka (1999) were among the first to use JA to measure field-of-study mismatch. Investigating the case of German workers, they used the 3-digit 1968 version of the International Standard Classification of Occupations (ISCO) and defined an individual as having a mismatch if the ISCO-code for one's 'occupational education' and one's first occupation were different. They found a mismatch incidence between 23% and 27%. Also Wolbers (2003) used 3-digit ISCO codes to investigate field-of-study mismatch among school leavers from 13 European countries. All fields were distributed into eight major field clusters, which were matched with a number of occupations on the basis of the author's assumed correspondence of the skills acquired through the field of study and those needed in the occupation.

Along with the ISCO classification, several other classifications have been used. Nordin *et al.* (2010) relied on 3-digit codes of the Standard Swedish Occupational Classification to determine the incidence of field-of-study mismatch among Swedish graduates. Based on this classification, they defined 34 different occupations. Their educational attainment measure was based on a classification that fits the International Standard Classification of Education (ISCED97). Domadenik, Farčnik and Pastore (2013) adopted the same combinations of occupations and fields of study as Nordin *et al.* (2010). They found an incidence of mismatch of 29% for 2007 and 55% for 2009 and attributed this high incidence to the great recession.

Most of these studies distinguished two categories only: match and mismatch. Only Nordin *et al.* (2010) considered an intermediate "weakly matched" category. Evidently, this more strict definition of the mismatch category causes the incidence of mismatch to be relatively lower. While the average mismatch incidence relying on JA across studies equals 35%, Nordin *et al.* (2010) found average incidences of 23% and 17% for men and women respectively. The incidences of 'weak matches' were 18% and 8% respectively. Regarding the decision to consider the middle category either as match or mismatch or to keep it as a separate category, similar arguments can be put forward as with respect to the WA approach.

But also among studies not distinguishing a third category, there is substantial variation in the measured incidence, ranging from 23% to 59%. These differences may be due to country-specific factors (for instance differences in economic conditions or educational systems) or differences in the composition of the sample, but also to differences in how the JA measure is constructed. Occupational classifications may differ in the description of job functions or in the extent to which jobs are aggregated. Educational programs may be clustered into more narrowly

or more broadly defined fields and their number may differ in the respective studies. Evidently, higher aggregation levels deliver lower mismatch estimates. Although the impact of the aggregation level of educational programs also applies to the measurement of overeducation (Verhaest & Omey, 2006), it is rarely discussed in the literature.

Realized Matches (RM)

The RM method is a third approach to measure of field-of-study mismatch. To determine the required education, this approach uses the actual distribution of educational levels or fields within the different occupations. In the overeducation literature, its usage is not uncommon. The required level of education is often measured using the mean educational level within one's occupation (Verdugo & Verdugo, 1989). Other authors prefer to use the modal (Kiker, Santos & De Oliveira, 1997) or median (Verhaest & Omey, 2010) level of education. Among the studies listed in Table 1, only Nieto *et al.* (2015) relied on this method. They assumed that someone has a field-of-study mismatch if his or her field of study differs from the modal field within one's occupation. They noted an incidence of field-of-study mismatch of about 40%.

Evaluation of the different measurement approaches

The literature on overeducation did already discuss intensively the advantages and disadvantages of each of the aforementioned measurement approaches. However, while much of this also applies to using the same approaches to measure field-of-study mismatch, the pro's and con's do not necessarily matter to the same extent. In fact, some drawbacks may be more problematic or more advantageous when used to measure field-of-study mismatch.

A first criterion to evaluate the approaches is the extent to which each method truly covers the concept one is actually trying to measure. In the overeducation literature, it is usually claimed that JA fits the concept of overeducation quite closely (Hartog, 2000). As far as fields of study are assigned to occupations on the basis of the extent to which they sufficiently prepare for these occupations and not, for instance, on actual recruitment behaviour, the same claim can be made with respect to the measurement of field-of-study mismatch. Whether measures based on WA also fit the concept of field-of-study mismatch depends on the specific wording of the survey question. The aforementioned question in the REFLEX survey, which refers to the field of study that is most appropriate for the job, seems more appropriate than questions not explicitly referring to the field of study or questions referring to the field required to get the job.[9] RM is most prone to the criticism that it is not able to cover the concept of field-of-study mismatch. This approach may be suitable when mismatches only result from

[9] The overeducation literature shows that referring to the level required to get the job or to do the job makes a difference (Green *et al.*, 1999).

search and matching frictions (Borghans & de Grip, 2000). In such a context, the modal field of study within an occupation is likely to be appropriate for the job. However, this should not be the case when mismatches also result from imbalances between the demand for and the supply of fields of study. In this case, the modal field of study may shift to a field that is inappropriate for the job but popular among graduates.

If an indicator does not completely fit field-of study mismatch or even measures a different concept, the incidence of mismatch will be systematically biased. But many other factors may cause the same problem. In the case of JA, the underlying classification system has to be updated from time to time to account for technological and organizational changes. It is often claimed that, in the case of overeducation, this causes the incidence to be overestimated since many jobs have become more complex. While the findings of the literature review reported above are consistent with the suggestion of a similar overestimation in the case of field-of-study mismatch, the problem should not necessarily be as severe in the latter case. After all, one may expect the content of the programs within the educational system to be adapted to the changing labour market needs. Moreover, this may cause the incidence of field-of-study mismatch among older workers actually to be underestimated since their education may no longer offer the optimal preparation for their job. A problem particular to the WA approach may be social desirability bias (Hartog, 2000). The problem is evident with respect to overeducation, since higher required levels of education may be associated with higher levels of prestige. Overall, this will cause overeducation to be underestimated. However, also in this case, a systematic negative bias may be less evident for field-of-study mismatch. After all, being employed within an occupation matching one's field of study should not necessarily be more prestigious than being employed in another occupation. Finally, also in the case of RM, other sources of systematic bias may exist. One problem, specific to the measurement of field-of-study mismatch, is that it is based on the assumption that for each job there is just one program or field of study that provides an optimal preparation. This is unlikely to be the case for every occupation, thus causing the estimated incidence of mismatch on the basis of RM to be upwardly biased.[10] The relatively high incidence found in the study of Nieto *et al.* (2015) is consistent with this argument, although more research is needed to determine whether this is a systematic finding.

Some errors in the measurement of the educational requirements may not be systematic. The extent to which each approach is able to avoid these types of errors is another evaluation criterion. It is usually claimed that this problem is more severe in the case of JA and RM (e.g. Halaby, 1994). After all, the classification of jobs into occupational classifications is not straightforward. At least, this requires detailed information concerning the tasks that workers

[10] To minimize this problem, an alternative may be to assume that all fields of study that account for a critical proportion of employees in an occupation (for instance at least 20%) are appropriate. Yet, the choice of this critical lower bound is inherently arbitrary.

execute, information that is often not collected in surveys[11]. A related problem is the heterogeneity in tasks among jobs classified within the same occupational code (see Tijdens, De Ruijter & De Ruijter, 2014, for evidence on this). Hence the importance of relying on classifications that go in sufficiently enough detail in terms of the types of tasks to be executed, in particular in the case of JA. In the case of RM, however, this may not always solve the problem given the need to have a sufficient number of observations within each code to derive the modal field of study. Evidently, this problem does not apply to WA. After all, no one knows the content of the job better than the one who performs it. Nonetheless, but for other reasons, also WA measures are prone to random measurement error. Respondents with similar jobs may interpret survey questions in different ways (Hartog, 2000). For instance, while it might be clear to the researcher what is meant with the 'appropriate' field of study, this is not necessarily true for the respondent. A related problem, but again only in the case of the direct WA method, is that the concept of 'field of study' may also be interpreted in different ways. While some respondents may consider any other than their own program not belonging to their own field of study, others may rely on a more aggregate categorization. Hence the importance of being as clear as possible and eventually providing additional instructions to the respondent about how the question should be interpreted.

Finally, the extent to which non-systematic errors in assessing the educational requirements are problematic partly depends on the type of analysis undertaken. While it should not affect conclusions concerning those categories of workers that face the highest incidence of mismatch, it may cause the overall incidence of mismatch to be over-estimated. This will in particular be the case when mismatch is an infrequent state, resulting in more workers being wrongly classified as having a mismatch than the other way around. Further, it may cause the overall persistence of mismatch over time for individuals to be underestimated. Finally, it will cause estimates on the effects of mismatch on wages and job satisfaction to be biased. In general, these estimates will be biased towards zero. However, when the error term happens to be correlated with the outcome variable, it may just as well cause the effect to be overestimated. This may in particular be the case for the WA approach. Respondents may not only try to be consistent in their answers to survey questions, their answers may also be influenced by their mood state (Podsakoff *et al.*, 2003). Being in a negative mood may thus cause individuals to answer both being dissatisfied with their job and having a bad match, although this problem should be less prominent in case the question concerning mismatch is posed in a neutral wording.

[11] In reviewing the measurement of occupations in large-scale surveys in Europe and the United States, Tijdens (2014) found that additional questions concerning the job description were only included in 14 out of 25 surveys.

ADDITIONAL EVIDENCE

This section aims at providing further insights in the influence of using alternative approaches to measuring field-of-study mismatch by applying the three methods to the same data-set. Besides, with respect to the WA approach, we differentiates between the direct (DWA) and the indirect (IWA) operationalization. Three questions guide the analysis. First, to what extent do the different measures result in different outcomes with respect to the incidence of field-of-study mismatch and to what extend are they correlated? Second, what is the impact of decisions concerning the assignment of the middle category or the 'no particular field required category' and the role of using different levels of aggregation with respect to the fields of study clusters? Finally, do different approaches lead to different conclusions concerning the individual characteristics that predict field-of-study mismatch?

Data and measurement

We rely on the SONAR data regarding the transition from school to work in Flanders. This dataset contains data on three cohorts of about 3000 Flemish young individuals, born in the years 1976, 1978 and 1980 respectively. Each cohort was interviewed at age 23. Follow-up surveys were conducted at age 26 for the cohort 1976 and 1978. For the cohort 1976 and 1980, data are also available at age 29. The response rates for these follow-up surveys ranged from 60% to 70%.

This study focusses on individuals with a first registered job, defined as the first job with a standard labour contract in which the graduates worked for at least one month. A first job is observed for 8247 individuals. Like most studies on field-of-study mismatch, we focus on higher educated individuals, i.e. those with a college or university degree. In total, 3483 individuals are higher educated and have a first registered job that was observed at the time of the last survey in which the individual participated. After further exclusion of those who are self-employed and respondents with missing values, the final sample consists of 3317 individuals.

The SONAR questionnaire included two questions in which the respondents are asked about their field of study (mis)match status. The first question allows to derive a DWA measure and is formulated as follows: "Was the content of your first job in line with your education?". Respondents could choose among: (1) completely, (2) somewhat in line (3) not at all in line. In our benchmark analysis, we define the first two answers as horizontal match and the latter category as mismatch. In the results section, we will also discuss whether the results differ if we use another categorization. This question is closely related to the one used in the seminal study by Robst (2007a). Our measure may be criticized on the grounds that it does not explicitly refer to the field of study. Yet, both the fact that it does refer to the content of the job (instead of the level of the job) and the fact that the question was preceded by a direct question concerning over- and undereducation should make clear that the focus

of the question is not on the vertical but the horizontal fit between education and work. Moreover, even if the question were interpreted as referring to both types of mismatch, it would be more reasonable for those who combine a vertical mismatch with a horizontal match to answer their job being "somewhat in line" than "not at all in line" with their education. Consequently, this should not affect the estimated incidence of mismatch in our benchmark analysis.

The second worker-assessment measure is an indirect measure (IWA). Respondents were asked about the educational level and the field of study that was required to get the job. First, the respondents got the question whether any educational qualification was required. They could answer the question with 'yes' or 'no'. If the respondents answered this question affirmative, they got the following question: 'Which fields of study were required by the employer?' If needed, respondents were able to report more than one detailed field of study that was required for the job. In total, more than 400 different fields of study were reported. We clustered these fields in two different ways, using (A) detailed clusters of fields of study and (B) broad clusters of fields of study, respectively. For categorization A, we clustered both the reported required fields and the graduate's attained field into 177 detailed categories. For categorization B, we clustered the fields of study in 11 broader categories[12]. In the case of correspondence between the attained category and at least one of the required categories, graduates were assumed to have a match on the basis of the IWA measure. Apart from those reporting one or more required fields, a substantial group did not report any particular required field. These individuals are classified in a separate mismatch group called 'no particular field of study was required'. In our analysis, we will rely both on categorization A and B. Regarding the 'no particular field of study was required' category, we report analyses in which this category is defined as a mismatch as well as in which it is considered as a match. Note that the usage of the term worker assessment may be criticized since the question actually refers to the formal requirements set by the employer. Therefore, labelling this alternatively as 'Employer-assessment' approach may be defensible. Nonetheless, given that the information concerning the requirements was given by the worker, we follow the literature and keep the 'indirect worker-assessment' label.

To determine mismatch based on JA, we rely on the 1992 Standard Occupation Classification of Statistics Netherlands.[13] This classification defines for each job the specific tasks and the corresponding requirements in terms of educational level and field of study. The fact that the original classification was developed about 10 years

[12] We distinguished the following fields of study: (1) General fields of study, (2) Economics, Business and Law, (3) Natural Sciences, Applied Natural Sciences and Technique, (4) Arts, (5) Biological and Applied Biological Sciences, (6) Health and Welfare, (7) Architecture, (8) Education (9) Social Sciences, (10) Philosophy, Literature and Applied Linguistics, and (11) Fields of study preparing for occupations in the Armed Forces. Given our focus on tertiary education graduates, the first or the last category is not included in our analysis.

[13] Along with an open format question on the job title, the SONAR data contained open format questions concerning the tasks that were executed and the activities of the firm, and closed-format questions on the number of individuals one was supervising and the firms size. Further, the interviews were conducted face-to-face allowing to the interviewers to urge the interviewees to be as detailed as possible in their answers to the open-format questions.

prior to the year in which the graduates in our sample entered the labour market is clearly a disadvantage. However, this problem may be minor for two main reasons. First of all, rather than being structured on the basis of job titles, the classification takes the executed tasks and the corresponding requirements as starting point. This results in relatively homogeneous requirements within each occupational code. The classification is therefore relatively flexible and allows to classify jobs with similar titles at different codes. Similarly, new jobs can be classified under codes with similar tasks and requirements. Secondly, an update version of the classification with 3000 new functional descriptions of the original occupational codes was published in 2001. Apart from the first survey of the 1976 cohort, all other surveys were coded following this update.

Since the CBS classification was originally developed for The Netherlands, we adapted it to the Flemish educational context. Based on additional information provided by Statistics Netherlands (CBS, 2001) and information about the required learning outcomes of the various study programs in Flanders, we examined which fields of study match the competencies required for every occupational discipline. The CBS classification distinguishes 65 occupational disciplines at the 3-digit level. Regarding the field of study of the program attained by the graduate, we consider 177 detailed clusters (cf. IWA measure). Each detailed field was matched with one or more professional disciplines. We differentiate between professional disciplines that are to a large extent related to the field of study and those who are to some extent related to the field of study.[14] In the benchmark analysis, individuals whose field of study was at least to some extent related with the professional discipline are defined as being horizontal matched. Individuals with a completely different field are defined as being horizontal mismatched. Additionally, we report results relying on other categorizations.

Finally, to compute horizontal mismatch based on realized matches, we use the modal procedure. To keep enough observations in each occupation, we rely on the 3-digit occupational code (cf. supra). Individuals are assumed to have a field-of-study mismatch if their field of study differs from the modal field of study within each occupation. Regarding the categorization of fields of study, we distinguish again between the aforementioned two different levels of aggregation.

The incidence of field-of-study mismatch

In Table 2 we report the incidence of field-of-study mismatch based on the four approaches. For the IWA, JA and RM measures, we distinguish between two levels of aggregation for the fields of study (A versus B, with A being based on a more detailed clustering). For the DWA and JA measures, we initially distinguish three categories: (1)

[14] The conversion table is available upon request.

Match, (2) Rather match, and (3) Mismatch. For IWA, we initially consider the third category 'no particular field of study was required' as a separate category.

TABLE 2 - THE INCIDENCE OF HORIZONTAL MISMATCH

	DWA	IWA (A)	(B)	JA (A)	(B)	RM (A)	(B)
Match	59.2%	44.1%	54.1%	59.0%	74.4%	38.1%	70.0%
Rather match	25.0%	-	-	16.4%	10.3%	-	-
Mismatch	15.8 %	34.5%	24.5%	24.6 %	15.3%	61.9%	30.0%
No particular field required		21.4%	21.4 %				

Data source: SONAR, own calculations; number of individuals = 3317

The incidence of measured horizontal mismatch largely depends on the used measurement approach, and ranges from about 15% for JA (B) and DWA to 62% for RM (A). Regarding DWA, this is below the average of 21% but between the minimum (5%) and maximum (35%) found in other studies relying on this method (cf. Table 1). For JA (B), this is in line with the results of Nordin *et al.* (2010), who found an incidence of mismatch about 17% by also distinguishing a separate category for 'weak matches'. Nonetheless, it is much lower than the average in the literature based on this measure (35%). While the mismatch incidence is relatively similar for the JA (B) and DWA method, we find some differences in the distribution across the 'Match' and 'Rather match' categories. Based on JA (B) three quarters of the individuals are found to have a complete match, while only 60% is found to have a complete match relying on DWA. The highest incidence of mismatch is found for RM (A) (61.9%). This finding is consistent with our earlier claim that RM measures overestimate the incidence of field-of-study mismatch by assuming that every occupation has just one appropriate program or field, although the lower estimate for RM (B) suggests that relying on a more aggregate classification of fields of study at least partly mitigates this problem. Finally, relying on IWA, 25% to 35% of the individuals have a field-of-study mismatch at the start of the career. However, more than 21% of the individuals also report that for their job no particular field was required. This latter percentage is substantially higher than what is usually found for this category in the literature when relying on DWA.[15] It thus seems that, even when one or some fields of study are more appropriate than others, many employers do not set specific hiring requirements. They may do so for several reasons, for instance because they have vacancies that are difficult to fill or because they aim at attracting also individuals that compensate their lack of appropriate formal qualifications with appropriate work experience.

[15] This is also confirmed when looking at the Flemish Reflex data, which include a similar cohort of Flemish graduates. Based on this sample and relying on DWA, only 12% of the Flemish graduates reported that no field was required.

Along with substantial differences between the four approaches, the incidence of horizontal mismatch also differs within each approach depending on the level of aggregation regarding the fields of study. As expected, we find a higher incidence of field-of-study mismatch if we rely on a more detailed clustering (category A). This difference ranges from about 10 to 30 percentage points.

As mentioned in the literature review section, most studies distinguish only between two categories: field-of-study match versus field-of-study mismatch. Individuals with a somewhat related job are usually defined as having a match, but some authors also define these individuals as having a mismatch. Further, individuals in a job where no particular field of study was required are usually defined as having a mismatch. It is clear that the decision regarding the way the different categories are matched will affect the results. To compare our results with other studies, we also report results by distinguishing two categories only. First, we consider individuals with a job that is somewhat in line with their field of study (DWA and JA) as having a match and individuals reporting that no field of study was required (IWA) as having a mismatch. Results are shown in Table 3. Using this dichotomous categorization, the incidence of matches is now by far the lowest relying on IWA. Less than half of the sample (44%) is now assessed to have a match if we use the more detailed clustering for the fields of study. On the other hand, relying on DWA, this dichotomization delivers an incidence of up to 84% matches. But also other types of classifications may be considered. As already noted, Boudarbat and Chernoff (2012) defined the 'rather match' category as 'mismatch'. Evidently, this procedure delivers a much higher incidence of mismatches. In our case, we would note a mismatch incidence of 40.8% (25.0%+15.8%) in the case of DWA and of 25.6% (10.3%+15.3%) to 41.0% (16.4%+24.6%) in the case of JA (see Table 2).

TABLE 3 - THE- INCIDENCE OF HORIZONTAL MISMATCH (MATCH VERSUS MISMATCH)

	DWA	IWA		JA		RM	
		(A)	(B)	(A)	(B)	(A)	(B)
Match	84.2%	44.1%	54.1%	75.4%	85.7%	38.1%	70.0%
Mismatch	15.8%	55.9%	45.9%	24.6%	15.3%	61.9%	30.0%

Data source: SONAR, own calculations; number of individuals =3317.

Correspondence between the different measures

The fact that different measures deliver different outcomes is also illustrated in Table 4, reporting the correlations between the mismatch indicators relying on the dichotomous operationalization (as reported in Table 3). Even among measures relying on a similar methodology but using a different level of aggregation, correlations are fairly low: 0.427 for RM, 0.655 for JA and 0.817 for the IWA measures. Not surprisingly, correlations between measures using different approaches are even lower. First, the correlations between the DWA measures and the other

measures are relatively stable and between 0.235 (with RM (B)) and 0.342 (with JA (A)). The correlations between the IWA measures and the other measures are the lowest (between 0.141 and 0.290. Finally, the correlation between the RM and the JA measures are between 0.215 and 0.655. The JA measures have slightly stronger correlations with the DWA (between 0.290 and 0.342) than with the IWA measures (between 0.141 and 0.230).

TABLE 4 - CORRELATIONS BETWEEN THE DIFFERENT MISMATCH MEASURES

		DWA	IWA (A)	IWA (B)	JA (A)	JA (B)	RM (A)	RM (B)
DWA		1.000						
IWA	(A)	0.279	1.000					
	(B)	0.290	0.817	1.000				
JA	(A)	0.342	0.230	0.229	1.000			
	(B)	0.290	0.141	0.195	0.655	1.000		
RM	(A)	0.240	0.275	0.198	0.367	0.215	1.000	
	(B)	0.235	0.177	0.203	0.598	0.532	0.417	1.000

Data source: SONAR, own calculations; number of individuals =3317.

These correlations suggest that the correspondence between the different measures is relatively low. This is in line with what has been found in similar research on overeducation (Verhaest & Omey, 2006). This low correspondence is also illustrated in Table 5, which reports the percentage of individuals that are classified identically on the basis of a minimum number of measures (relying on categorization B). While 61.1% of the graduates had a horizontal mismatch on the basis of at least one measure, only 5.6% had a mismatch on the basis of every measure. Overall, only 44.5% of the respondents are equally classified on the basis of the four measures (5.6% with a mismatch and 38.9% with a match).

TABLE 5 – CORRESPONDENCE BETWEEN THE MEASURES OF FIELD-OF-STUDY (MIS)MATCH

At least on the basis of … measure(s)	Field-of-study mismatch	Field-of-study match
1	61.1%	94.4%
2	27.6%	87.3%
3	12.0%	50.0%
4	5.6%	38.9%

Data source: SONAR, own calculations; number of individuals =3317; based on Category B for IWA, JA and RM.

Field-of-study mismatch and overeducation

Our dataset also provides information about the overeducation status of individuals. In Table 6, we report the incidence of the combination between overeducation and horizontal mismatch, using a similar methodology for

both types of mismatch[16]. Like Støren and Arnesen (2011) and Verhaest *et al.* (2017), we distinguish the following categories[17]: (1) Full Match, (2) Mere Vertical Mismatch, (3) Mere Horizontal Mismatch, and (4) Full Mismatch.

By far the largest incidence of full matches is observed when using DWA; almost 73% of our sample is considered to have no mismatch problems when relying on this method. The IWA and JA methods deliver lower but relatively similar incidences of full matches of about 42% to 48%. Also the RM methodology delivers lower incidences of full matches, but in this case the incidence is more dependent upon the level of aggregation and ranges from 34% (categorization A) to 51% (categorization B). The high incidence of full matches when relying on DSA is mirrored in a relatively low incidence of full mismatch of about 11%. But also the JA (B) method delivers a relatively low percentage of full mismatches of about 10%. For most of the other indicators, this incidence is relatively similar and ranges from 18% when relying on RM (B) or JA (A) to 25% when relying on IWA (A). The RM (A) measure again seems to be an outlier with an incidence of full mismatches of about 33%.

TABLE 6 - INCIDENCE OF FIELD OF STUDY MISMATCH AND OVEREDUCATION

	DWA	IWA		JA		RM	
		(A)	(B)	(A)	(B)	(A)	(B)
Full Match	72.6%	41.5%	48.1%	41.7%	43.7%	34.4%	51.0%
Mere vertical mismatch	11.6%	2.6%	6.1%	33.8%	41.0%	3.7%	18.9%
Mere horizontal mismatch	4.4%	31.1%	24.5%	7.1%	5.1%	28.8%	12.2%
Full Mismatch	11.4%	24.9%	21.4%	17.5%	10.2%	33.0%	17.8%

Data source: SONAR, own calculations; number of individuals =3317

By far the strongest variation is noted with respect to the 'mere horizontal mismatch' and 'mere vertical mismatch' categories. While the former ranges from 4.4% when relying on DWA to 31.1% when relying on ISA (A), the latter ranges from 2.6% only when relying on IWA (A) to 41.0% when relying on JA (B). While the DWA and JA methods seem to deliver relatively large incidences of mere vertical mismatch, the IWA and RM methods seem to attach relatively more weight to mere horizontal mismatch.[18] But also the level of aggregation matters with more detailed levels of aggregation regarding fields of study (A as opposed to B) evidently delivering relatively higher incidences of mere horizontal mismatch and relatively lower levels of mere vertical mismatch. Interestingly, among those measures that are most closely related to our concept of mismatch (DWA and JA), we do find more

[16] For more information about the measurement of overeducation relying on the SONAR data, we refer to Verhaest and Omey (2006). Regarding the measurement of overeducation, no differentiation in terms of aggregation levels is applied.

[17] The so-called undereducated are considered to have a vertical match.

[18] As discussed in the methods section, there were some concerns that our DSA measure of horizontal mismatch picks up vertical mismatch. However, the relatively large incidence of mere vertical mismatch based on DSA is not consistent with this view.

divergence with respect to vertical than with respect to horizontal mismatch. This seems consistent with the idea that social desirability and occupational upgrading bias are less of a problem for the latter than for the former.

Transition rates

Next, relying on a subsample of the dataset for which we also observe the match status at age 29, we assess whether the transition rates between the mismatch statuses differ across the measures. As shown in Table 7, horizontal mismatch is relatively more persistent at the individual level when relying on JA and RM measures than when relying on SA measures. Many explanations may be provided for this observation. On the one hand, JA and RM measures may overestimate the persistence of mismatches if they insufficiently account for adjustments over time in the tasks executed by individuals with an initial mismatch. On the other hand, SA measures may underestimate mismatch persistence if respondents interpret questions about mismatches in a different way across the waves of the study.

TABLE 7 – TRANSITION RATES BETWEEN THE START OF THE CAREER AND AGE 29

	Status at Age 29							
	DWA		IWA (B)		JA (B)		RM (B)	
	Match	Mismatch	Match	Mismatch	Match	Mismatch	Match	Mismatch
Initial Status								
Match	93.5%	6.5%	84.4%	15.6%	94.6%	5.4%	87.8%	12.2%
Mismatch	72.6%	27.4%	63.9%	36.1%	36.1%	63.9%	24.1%	75.9%

Data source: SONAR, own calculations; number of individuals = 1265

The determinants of field-of-study mismatch: standard measures

Finally, we assess whether the determinants of field-of-study mismatch, like gender, ethnicity and educational background characteristics differ if one uses alternative measurement approaches and aggregation levels. Regarding the educational background, we investigate the role of the educational level (higher versus lower tertiary degree), field of study and academic performance in terms of grades and repeated years.[19] These characteristics have regularly been investigated in the literature on educational mismatches (Robst, 2007a; Verhaest & Omey, 2010). For the outcome variable (field-of-study mismatch), we rely on the dichotomous categorization (cf. Table 3). The analysis is conducted by means of logistic regression. The estimation results are reported in Table 8.

[19] We also include a number of additional variables as control variables. These are dummies for cohort year (2 dummies), having a child (1 dummy) and cohabiting (1 dummies). To account for eventual time trends, we include the year of observation and its square.

TABLE 8 - THE PROBABILITY OF FIELD-OF-STUDY MISMATCH – LOGISTIC REGRESSION COEFFICIENTS (AND STANDARD ERRORS)

	DWA	IWA		JA		RM	
		(A)	(B)	(A)	(B)	(A)	(B)
Personal and social background characteristics							
Male	-0.048	0.057	-0.040	0.031	-0.032	0.023	-0.015
	(0.060)	(0.054)	(0.054)	(0.055)	(0.063)	(0.052)	(0.057)
Non-Western background	0.198	-0.001	-0.018	0.077	0.005	-0.286	-0.149
	(0.280)	(0.260)	(0.247)	(0.269)	(0.327)	(0.244)	(0.275)
Education father							
(Primary education = Reference)							
Lower secondary education	0.039	-0.053	-0.102	0.232*	0.161	-0.165	-0.015
	(0.132)	(0.126)	(0.122)	(0.126)	(0.146)	(0.114)	(0.127)
Higher secondary education	-0.062	-0.109	-0.075	0.069	-0.011	-0.074	-0.008
	(0.124)	(0.117)	(0.114)	(0.118)	(0.138)	(0.106)	(0.118)
Tertiary education	-0.050	-0.082	-0.021	0.127	0.066	-0.010	-0.082
	(0.122)	(0.116)	(0.112)	(0.117)	(0.136)	(0.106)	(0.117)
Unknown	-0.150	0.143	0.126	0.158	0.185	0.008	0.139
	(0.167)	(0.153)	(0.148)	(0.151)	(0.171)	(0.138)	(0.151)
Educational characteristics							
Higher tertiary education degree	0.039	0.171**	0.132**	0.116	0.228***	0.531***	0.365***
	(0.072)	(0.065)	(0.065)	(0.067)	(0.081)	(0.064)	(0.068)
Fields of study							
(Economics, Business, and Law = Reference)							
Linguistics, History and Philosophy	0.320***	0.149	0.402***	0.982***	1.631***	0.149	2.570***
	(0.120)	(0.117)	(0.116)	(0.112)	(0.121)	(0.124)	(0.162)
Behavioral and Social sciences	0.117	0.060	0.131	0.531***	0.879***	-0.046	1.152***
	(0.088)	(0.084)	(0.084)	(0.084)	(0.095)	(0.081)	(0.085)
Health and (para)medicine	-0.615***	-0.431***	-0.510***	-0.284***	-0.124	-0.783***	0.175*
	(0.106)	(0.081)	(0.083)	(0.094)	(0.120)	(0.075)	(0.092)
Natural Sciences and Engineering	-0.021	-0.148**	-0.340***	0.486***	0.313***	0.087	0.973***
	(0.077)	(0.071)	(0.071)	(0.071)	(0.090)	(0.069)	(0.074)

Arts	0.289*	0.547***	0.817***	0.786***	1.255***	0.423**	1.746***
	(0.160)	(0.173)	(0.165)	(0.150)	(0.156)	(0.181)	(0.162)
Education	-0.512***	-0.459***	-0.374***	0.149*	0.725***	-0.510***	0.497***
	(0.100)	(0.082)	(0.083)	(0.084)	(0.095)	(0.073)	(0.088)
Academic performance							
Graduating with a distinction grade	-0.217***	-0.195***	-0.221***	-0.140**	-0.056	-0.136***	-0.105*
	(0.059)	(0.053)	(0.053)	(0.054)	(0.063)	(0.050)	(0.056)
Graduating with high or highest distinction grade	-0.343***	-0.222**	-0.326***	-0.068	-0.113	-0.105	-0.073
	(0.107)	(0.089)	(0.090)	(0.090)	(0.106)	(0.086)	(0.098)
Repeated Years	0.061	-0.058	-0.053	0.096**	0.141***	-0.004	0.026
	(0.049)	(0.045)	(0.045)	(0.046)	(0.053)	(0.045)	(0.049)

Data source: SONAR, own calculations; number of individuals =3317.

Control variables: cohort (2 dummies), having a child (1 dummy), cohabiting (1 dummy), year of observation (and its square)

*p<0.10;**:p<0.05;***:p<0.0

Regarding personal characteristics, there is some statistically significant evidence with respect to the educational level of the father, but only based on the JA and relying on the most detailed categorization A (Table 8, JA column 1). On the basis of this measure, having a father with a lower secondary education degree results in a higher likelihood of a horizontal mismatch in comparison to those with a father without secondary education degree.

Educational characteristics seem more important in explaining horizontal mismatch. In line with the idea that programs in lower tertiary education (organized by colleges) are on average more labour market oriented than programs in higher tertiary education (mostly organized by universities), individuals having participated in higher tertiary education are more likely to be horizontally mismatched. However, this effect is not statistically significant when relying on DWA or JA (A).

Conclusions with respect to field of study are even more dependent on the measurement approaches and aggregations levels used. The most consistent outcome is found for graduates from Arts. Whatever the measurement approach and used level of aggregation, these graduates are found to have a statistically significantly higher probability of field-of-study mismatch than graduates from Economics, Business and Law (the reference category). Also for graduates with a degree in Linguistics, History or Philosophy and those with a degree in Behavioral and Social Sciences, there is some evidence of a higher likelihood for being mismatched in comparison to the reference category. These results are in line with findings of earlier studies (Wolbers, 2003; Robst, 2007a). One explanation is that less vacancies are available for these graduates, forcing them to accept jobs outside their field of study. However, the result is not statistically significant for all measures. In particular for graduates from Behavioral and Social sciences, the conclusion of a higher incidence of mismatch can only be sustained by a few of the mismatch indicators. For some other fields, we even find contrasting results. For instance, we note a lower incidence of field-of-study mismatch for graduates in Health and Medicine in comparison to those with an Economics, Business and Law degree on the basis of five out of seven measures. However, this lower risk of mismatch is not found when relying on JA (B). Moreover, relying on RM (B), we note a higher incidence of mismatch for those with a degree in Health and Medicine. The difference in outcomes is even more pronounced with respect to the effect of graduating with a 'Natural Science and Engineering' or an 'Education' degree. While both fields perform relatively well in avoiding mismatches in comparison to the field of 'Economics, Business and Law' when relying on the WA methods, the opposite is true when relying on the JA and the RM (B) measures.

The assessment of the relative effects of fields of study is complicated since the coefficients depend on the choice of the reference category. Therefore, we also look at the relative ranking of the different fields on the basis of the estimated coefficients. This ranking suggests that the divergence of results is largely driven by a divergence in ranking of the 'Economics, Business and Law' domain. While this domain is ranked fourth out of seven domains on the basis of the three WA measures, it ranks sixth on the basis of both JA measures. Programs in 'Economics, Business and Law' are usually relatively broad and provide skills which can be used in many types of jobs. For many of these jobs, in particular those with a broad range of tasks, this domain may thus provide the optimal

preparation. It thus seems that our JA measures are, more than other measures, able to account for this. Regarding the RM approach, results are not consistent for the two aggregation levels. While the domain 'Economics, Business and Law' ranks fourth on the basis of the most detailed clustering (A), it ranks seventh on the basis of a more broad clustering of fields of study (B). A straightforward explanation concerns the relative distribution of the graduates across the different fields of study. With 'Economics, Business and Law' being by far the most popular cluster of fields of study, this cluster may also be the modal cluster within occupations where a less popular field is more appropriate. However, this dominance of an inappropriate cluster over the appropriate one evidently becomes less likely once more homogeneous clusters with fewer observations are used, as in done on the basis of categorization (A).

Finally, we assess the role of academic performance as measured by the grade at graduation and the number of repeating years. Also with respect to these variables, we find some differences. While individuals who graduated with 'distinction' are found to have a lower incidence of horizontal mismatch based on all but one measure, those who graduates with 'high or highest distinction' are found to have a lower probability of field-of-study mismatch based on the WA measures only. Similarly, we only find statistically significant evidence regarding the role of repeated years if mismatch is being measured using JA; individuals who repeated years are found to have a higher probability of horizontal mismatch if measured on the basis of these measures. Overall, this is in line with similar studies focusing on overeducation, who also concluded that different measures of mismatch often have different predictors (Giret & Hatot, 2001; Verhaest & Omey, 2010; Ramos, 2014).

The determinants of field-of-study mismatch: alternative measures

In the previous analysis, individuals who work in a job that is somewhat related with their field of education according to the DWA or JA measure were defined as having a match. The idea behind this decision was that for many jobs a more general program may be optimal. However, not all studies in the literature follow this approach. Further, regarding the IWA measure, those answering that 'no particular field was required' were considered to have a mismatch. Yet as argued before, while this approach is defensible and conforms with most other studies, arguments in favour of considering these individuals as matched can be put forward as well. Therefore, we also report results with the middle category defined as mismatch (in the case of DWA and JA) and the 'no particular field required' category as match (in the case of IWA). These results are reported in Table 9.

In general, these alternative indicators do not provide much evidence that personal and social background characteristics matter for field-of-study mismatch. However, an exception is the effect of gender, which is strongly statistically significant when relying on the alternative definition for measure JA (B). Regarding the level of tertiary education, the results for most measures are similar to those relying on their standard version. However, different from when relying on the standard DWA measure, we now do find a significantly positive effect. The results regarding the role of academic performance are a bit mixed. For instance, relying on JA (A), we now find grades

to matter more than repeating years, whereas relying on the standard definition we found the opposite, i.e. grades being less important.

TABLE 9 - THE PROBABILITY OF FIELD-OF-STUDY MISMATCH (ALTERNATIVE DEFINITIONS) – LOGISTIC REGRESSION COEFFICIENTS (AND STANDARD ERRORS)

	DWA	IWA		JA	
		(A)	(B)	(A)	(B)
Personal and social background char.					
Male	-0.013	0.064	-0.028	0.069	-0.180***
	(0.050)	(0.053)	(0.059)	(0.051)	(0.057)
Non-Western background	-0.166	-0.186	-0.220	0.186	0.287
	(0.253)	(0.271)	(0.300)	(0.249)	(0.262)
Education father					
(Primary education = Reference)					
Lower secondary education	-0.088	-0.028	-0.130	0.075	-0.109
	(0.111)	(0.117)	(0.125)	(0.112)	(0.125)
Higher secondary education	-0.144	-0.113	-0.131	0.001	-0.152
	(0.103)	(0.109)	(0.117)	(0.104)	(0.116)
Tertiary education	-0.143	-0.173	-0.200*	0.039	-0.129
	(0.102)	(0.108)	(0.116)	(0.104)	(0.114)
Unknown	-0.210	-0.050	-0.015	0.067	0.004
	(0.135)	(0.141)	(0.150)	(0.137)	(0.149)
Educational characteristics					
Higher tertiary education degree	0.122**	0.258***	0.216***	0.060	0.231***
	(0.061)	(0.064)	(0.073)	(0.061)	(0.069)
Fields of study					
(Economics, Business, and Law = Ref.)					
Linguistics, History and Philosophy	0.095	0.155	0.243**	1.018***	1.729***
	(0.109)	(0.116)	(0.123)	(0.119)	(0.121)
Behavioral and Social sciences	-0.080	0.043	0.269***	0.352***	0.923***
	(0.078)	(0.083)	(0.091)	(0.078)	(0.085)
Health and (para)medicine	-0.797***	-0.128	-0.052	-0.698***	-0.071
	(0.079)	(0.080)	(0.089)	(0.081)	(0.096)
Natural Sciences and Engineering	-0.180***	-0.046	-0.204**	0.110*	0.695***
	(0.065)	(0.070)	(0.081)	(0.065)	(0.075)
Arts	-0.122	-0.369**	0.141	0.367**	1.377***
	(0.148)	(0.173)	(0.169)	(0.150)	(0.154)
Education	-0.653***	-0.087	0.184**	-0.360***	0.495***
	(0.077)	(0.082)	(0.089)	(0.076)	(0.086)
Academic performance					
Graduating with a distinction grade	-0.144***	-0.072	-0.132**	-0.156***	-0.073
	(0.049)	(0.053)	(0.058)	(0.050)	(0.056)
Graduating with high or highest	-0.348***	-0.053	-0.224**	-0.189**	0.044
distinction grade	(0.107)	(0.088)	(0.101)	(0.085)	(0.091)
Repeated Years	0.007	-0.062	-0.047	0.057	0.094**
	(0.043)	(0.045)	(0.050)	(0.043)	(0.048)

Data source: SONAR, own calculations; number of individuals =3317; control variables: cohort (2 dummies), having a child (1 dummy), cohabiting (1 dummy), year of observation (and its square); *p<0.10;**:p<0.05;***:p<0.01

More pronounced differences with the analysis relying on the standard definitions appear when focusing on the role of field of study. The most marked outcome concerns the domain of Arts. While this domain was consistently

ranked first or second in terms of field-of-study mismatch when relying on the standard measures, Arts is ranked fourth when relying on the alternative DWA and IWA (B) and even seventh when relying on the alternative IWA (A). An evident explanation is that graduates in Arts are either employed in jobs fitting perfectly with their education or in jobs without any relation with their education, but not in the in-between category. Further, the jobs without any relation with their education may be jobs at low functional levels requiring rather general skills. If so, graduating in Arts is clearly not the economically optimal preparation for these jobs. Therefore, classifying those individuals that report 'no field was required' as having no field-of-study mismatch, can be considered to be invalid. A similar explanation, but in the opposite direction, may be provided regarding the domain of 'Education'. While this domain scores usually relatively low in terms of field-of-study mismatch, it is ranked third when relying on the alternative definition for IWA (B). Earlier research relying on the same data has shown that overeducation is hardly a problem for this domain (Verhaest *et al.*, 2011), what may explain the relatively low number of individuals within this domain indicating that no field of study was required for their job. Therefore, the incidence of field-of-study mismatch is less likely to be underestimated due to the misclassification of these individuals as having a match. One last remarkable finding regarding the alternative definitions concerns the domain of 'Economics, Business and Law', which is now ranked second on the basis of the DWA measure. This aligns with our earlier arguments that graduates within broad domains are relatively less likely to be classified as having a match when the middle category is defined as mismatch.

CONCLUSION AND RESEARCH IMPLICATIONS

Both the review of the literature and the empirical analysis clearly demonstrate that decisions concerning the approach used to measure field-of-study mismatch matter for the outcomes of the analysis. Not only do these decisions affect which individuals are classified as having a field-of-study mismatch, they also affect the conclusions concerning the overall incidence of measured field-of-study mismatch, the extent to which field-of-study mismatch is combined with overeducation, and the individual characteristics that predict field-of-study mismatch. Moreover, this conclusion does not only apply to the choice of the overall approach, but also to the choice of the specific variant of each approach. Hence the importance of knowing which approach and which variant of this approach is to be preferred in which context.

Concerning the overall approach to the measurement of field-of-study mismatch, it is advisable to adhere at least to those approaches fitting as much as possible the concept of field-of-study mismatch. As argued in this paper, this is clearly not the case for the RM method and WA methods that rely on information concerning the requirements to be hired. Apart from the theoretical arguments against the use of these methods, also some empirical findings suggest that these approaches measure concepts that are different from the one measured by JA or the other WA approaches. First and foremost, both the literature review

and the empirical analysis indicated that these latter measures result in substantially higher incidences of field-of-study mismatch compared. Disregarding the results on the less appropriate measures, we found this incidence in the empirical analysis to range only from 15% to 25%. Second, our analysis suggested that, when relying on RM, the conclusions with respect to the fields of study associated with mismatch are partly driven by the relative popularity of these fields. Of course, due to which data are available, researchers may have no other option than relying on RM methods. In this case, the use of the RM methods may be defensible when field-of-study mismatch is not the core variable in the analysis, for instance because field-of-study mismatch only serves as a control variable or the main interest is the actual recruitment behaviour and matching patterns. The choice of the approach may also not be of fundamental importance as long as one is interested in the broad mechanisms affecting mismatch. Indeed, all measures consistently indicate factors such as field of study or academic performance to matter. However, as soon as one is interested in the impact of more specific fields of study or aspects of academic performance, as is likely to be the case in more policy-oriented research, it may matter much more which measures are being used.

This does not at all mean that every JA measure or WA measure is appropriate for measuring field-of-study mismatch without further consideration. As argued in the paper, it is advisable to rely for the JA method on an occupational classification that is detailed enough and is adapted from time to time to eventual technological changes, even if the latter point may be less of an issue when analysing field-of-study mismatch among young workers than when analysing overeducation or when focusing on older workers. Regarding the WA approach, we argued that it is important to be as clear as possible in the survey question by referring explicitly to 'field of study' to avoid any confusion with vertical mismatch or skill mismatch and by providing additional instructions about how the question should be interpreted. Moreover, although social desirability bias may be less of a problem for field-of-study mismatch than for overeducation, it is advisable to pose the question in a neutral wording and context to minimize any other type of subjective bias.

Even in the case this advice is taken into account, it is unlikely that any of these approaches measures field-of-study mismatch without error. For instance, the empirical analysis showed a relatively low correlation between our DWA and JA measures and neither were the results concerning the individual characteristics predicting field-of-study mismatch fully consistent. Therefore, as a robustness check, it is advisable to rely on both types of measures. Moreover the choice for WA vis-à-vis JA may also be determined by the type of analysis conducted. In case the focus is on young graduates in a specific country, a carefully conducted JA based on a detailed and appropriate occupational classification system may be preferable since any type of subjective bias and inconsistency in coding is avoided. This may also be the case when focusing on year-to-year changes in field-of-study (mis)match at the micro level, since any change in mood, satisfaction or preferences may cause the individual to change her answer to survey questions concerning field-of-study mismatch. However, the longer the time span in longitudinal research, the more a lack of updated

occupational classifications becomes a problem and, hence, WA methods may be preferred. Also when focusing on international comparisons, WA methods may be preferred because the classifications needed for the JA approach may insufficiently account for differences in the content of occupations and educational programs across countries. Nonetheless, given that answers to survey questions may be culturally biased, also WA methods may not be without problems in this case.

Apart from choosing the specific approach to the measurement of field-of-study mismatch, several other decisions are important.. This is clearly the case for the assignment of the middle category (both in the case of WA and JA) and the eventual assignment of a 'no field required' category (in the case of some WA measures). Concerning the middle category, we argued that assignment to the match category is advisable, as is done in most studies. But a different decision, such as leaving it as a separate category, may be made depending on the theoretical framework and the definition of mismatch. With respect to the 'no field required' category for WA measures based on questions regarding the educated required to do the job, we argued that assignment to the mismatch category seems most appropriate since this category may reflect individuals for which a general education without specific focus is more appropriate than a more specialized field of study. Nonetheless, it cannot be excluded that this category also includes some workers for which any field of study is appropriate. Therefore, it may be an option to replace the 'no field required' answer category in new surveys by two other categories, one indicating that 'a general education without specialization' is most appropriate and another one indicating that 'any or most fields of study' are appropriate.

In many cases, the choice of the approach to the measurement of field-of-study mismatch is not only based on substantive but also on practical considerations. From a cost perspective, WA methods are clearly preferable to JA methods. But despite the popularity of WA methods, there is little uniformity concerning the phrasing of the survey questions on which WA measures are based. We already referred to the difference between surveys asking whether the field of study is appropriate for the job and other studies asking whether the job aligns with their field of study. But also for each of these options, many variants circulate. Overall, the impact of the phrasing of survey question has attracted little attention in the literature on educational mismatch. While the data that were used in our own empirical analysis did not allow to test for the impact of these differences in phrasing, evidence from other subjects shows that even small differences in the phrasing of survey questions may have a substantial effect on the answers (e.g. Rasinski, 1989; Fowler, 1992). Hence the importance of further research on the validity and reliability of different ways of phrasing questions concerning mismatch, for instance by evaluating the correlation of different WA variants with a carefully conducted JA and by conducting test-retest analyses. Finally, apart from looking at whether these measurements affect the incidence and determinants of horizontal mismatch, we are also in favour of further research looking at the influence of these measurements when assessing the impact of mismatch on outcome

variables such as wages, job satisfaction or employment stability. Such research may not only contribute to the development of a generally accepted and cost-effective instrument for the measurement of field-of-study mismatches, it may also further enhance the credibility of field-of-study mismatch as a research topic.

REFERENCES

Allen J. and de Weert E. (2007) 'What Do Educational Mismatches Tell Us About Skill Mismatches? A Cross-country Analysis', *European Journal of Education*, 42: 59-73.

Allen J. and van der Velden R. (2001) 'Educational mismatches versus skill mismatches: effects on wages, job satisfaction, and on-the-job search', *Oxford Economic Papers*, 5: 434–452.

Arcidiacono P. (2004) 'Ability sorting and the returns to college major', *Journal of Econometrics*, 121: 343–375.

Battu H., Belfield C. and Sloane P. (2000) 'How well can we measure graduate overeducation and its effects?', *National Institute Economic Review*, 171: 82–93.

Béduwé C. and Giret J.-F. (2011) 'Mismatch of vocational graduates: What penalty on French labour market?', *Journal of Vocational Behavior*, 78: 68-79.

Borghans L. and de Grip A. (2000) 'The debate in economics about skill utilization', in: L. Borghans and A. de Grip (eds), *The Overeducated Worker?*, Cheltenham: Edward Elgar, 3–23.

Boudarbat B. and Chernoff V. (2012) 'Education-job match among recent Canadian university graduates', *Applied Economics Letters*, 19: 1923-1926.

CBS (2001). *Standaard beroepenclassificatie 1992 - editie 2001*.

Cohn E. and Khan S. (1995) 'The wage effects of overschooling revisited', *Labour Economics*, 2: 67–76.

Di Pietro G. and Urwin P. (2006) 'Education and skills mismatch in the Italian graduate labour market', *Applied Economics,* 38: 79-93.

Domadenik P., Farčnik D. and Pastore F. (2013) 'Horizontal Mismatch in the Labour Market of Graduates: The Role of Signalling', *IZA Discussion Paper,* No. 7527.

Finnie R., and Frenette M. (2003) 'Earnings differences by major field of study: Evidence from three cohorts of recent Canadian graduates', *Economics of Education Review*, 22: 179–192.

Fowler F. (1992) 'How unclear terms affect survey data', *Public Opinion Quarterly*, 56: 218-231.

Giret J. and Hatot C. (2001) 'Mesurer le déclassement à l'embauche: l'exemple de DUT et de BTS', *Formation Emploi*, 76: 59-73.

Grayson J. (2004) 'Social dynamics, university experiences, and graduates' job outcomes', *British Journal of Sociology of Education*, 25: 609-627.

Green F. and McIntosh S. (2007) 'Is there a genuine under-utilization of skills amongst the over-qualified?', *Applied Economics*, 39: 427-439.

Green F., McIntosh S. and Vignoles A. (1999) 'Overeducation and Skills. Clarifying the Concepts', *Center for Economic Performance Discussion Paper*, No. 435.

Groot W. and Maassen van den Brink H. (2000a) 'Overeducation in the labor market: a meta-analysis', *Economics of Education Review*, 19: 149–158.

Groot W. and Maassen van den Brink H. (2000b) 'Skill mismatches in the Dutch labor market', *International Journal of Manpower*, 21: 584–595.

Halaby C. (1994) 'Overeducation and skill mismatch', *Sociology of Education*, 67: 47–59.

Hartog J. (2000) 'Overeducation and earnings: where are we, where should we go?', *Economics of Education Review*, 19: 131–147.

Heijke H., Meng C. and Ris C. (2003) 'Fitting to the job: the role of generic and vocational competencies in adjustment and performance', *Labour Economics,* 10: 215-229.

Katz-Gerro T. and Yaish M. (2003) 'Higher Education: is more better? Gender differences in Labour Market Returns to Tertiary Education in Israel', *Oxford Review of Education,* 29: 571-592.

Kelly E., O'Connell P.J. and Smyth E. (2010) 'The economic returns to field of study and competencies among higher education graduates in Ireland', *Economics of Education Review*, 29: 650-657.

Kiker B.F., Santos M.C. and Mendes de Oliveira M. (1997) 'Overeducation and undereducation: Evidence for Portugal', *Economics of Education Review*, 16: 111-125.

Kim H.K., Ahn S.C. and Kim J. (2016) 'The Income Penalty of Vertical and Horizontal Education-Job Mismatches in the Korean Youth Labor Market: A Quantile Regression Approach', *Hitotsubashi Journal of Economics*, 57: 67-90.

Klein M. (2011) 'Higher education and non-pecuniary returns in Germany: tracing the mechanisms behind field of study effects at the start of the career', *Irish Educational Studies,* 30: 253- 270.

Kleiner M. (2000) 'Occupational licensing', *Journal of Economic Perspectives*, 14: 189-202.

Kucel A. and Vilalta-Bufi M. (2010) 'Is there a wage penalty to horizontal and vertical mismatch?', *DEMOSOC Working Paper*, No. 34.

Kucel A., Vilalta-Bufi M. and Robert P. (2011) 'Graduate Labor mismatch in Central and Eastern Europe', *Working Paper Collecció d'Economia*, Universitat de Barcelona, No. 259.

Leuven E. and Oosterbeek H. (2011) 'Overeducation and mismatch in the labor market', in: Hanushek, E., Machin, S., Woessman, L. (Eds.), *Handbook of the Economics of Education*, 4, 283–326.

Little B. and Arthur L. (2010) 'Less time to study, less well prepared for work, yet satisfied with higher education: a UK perspective on links between higher education and the labour market', *Journal of Education and Work*, 23: 275- 296.

Mavromaras K., McGuinness S., O'Leary N., Sloane P. and Wei Z. (2013) 'Job Mismatches and Labour Market Outcomes: Panel Evidence on Australian University Graduates', *Economic Record,* 89: 382-395.

McGoldrick K. and Robst J. (1996) 'Gender differences in overeducation, a test of the theory of differential overqualification', *American Economic Review*, 86: 280-284.

McGuinness S. (2003) 'Overeducation as a sheepskin effect: Evidence from Northern Ireland', *Applied Economics*, 35: 597–608.

McGuinness S. (2006) 'Overeducation in the labour market', *Journal of Economic Surveys*, 20: 387–418.

Nieto S., Matano A. and Ramos R. (2015) 'Educational mismatches in the EU: Immigrants vs. Natives', *International Journal of Manpower,* 36: 540-561.

Nordin M., Persson I. and Rooth D.O. (2010) 'Education-occupation mismatch: Is there an income penalty?', *Economics of Education Review*, 29: 1047-1059.

OECD (2012) *Education at a Glance 2012: OECD Indicators*. Paris: OECD Publishing.

Podsakoff P., MacKenzie S., Leen J.-Y. and Podsakoff N. (2003) 'Common method biased in behavioral research: a critical review of the literature and recommended remedies', *Journal of Applied Psychology*, 88: 879-903.

Ramos M. (2014) 'Mismatched mismatch measures. Does the definition of over-and underqualification matter?' *Paper presented at the XVII Applied Economics Meeting*, Gran Canaria, 5-6 June 2014.

Rasinski K. (1989) 'The effect of question wording on public support for government spending', *Public Opinion Quarterly*, 53: 388-394.

Robst J. (2007a) 'Education and job match: the relatedness of college major and work', *Economics of Education Review*, 26: 397-407.

Robst J. (2007b) 'Education, College Major, and Job match: Gender Differences in Reasons for Mismatch', *Education Economics*, 15: 159-175.

Robst J. (2008) 'Overeducation and college major: expanding the definition of mismatch between schooling and jobs', *The Manchester School*, 76: 349-368.

Sellami S., Verhaest D., Nonneman W. and Van Trier W. (2017) 'The impact of educational mismatches on wages: the influence of measurement error and unobserved heterogeneity', *The B.E. Journal of Economic Analysis & Policy*, 17. DOI: https://doi.org/10.1515/bejeap-2016-0055

Sloane P. (2003) 'Much ado about nothing?', in: Büchel F, de Grip A, Mertens A (eds), *Overeducation in Europe*, Cheltenham: Edward Elgar, 11–45.

Solga H. and Konietzka D. (1999) 'Occupational Matching and Social Stratification', *European Sociological Review*, 15: 25-47.

Støren L.A. and Arnesen C.A. (2011) 'Winners and losers', in: J. Allen and R. van der Velden (eds.), *The Flexible Professional in the Knowledge Society*, Dordrecht: Springer, 199-240.

Tijdens K. (2014) 'Reviewing the measurement and comparison of occupations across Europe', *AIAS Working Paper*, Universiteit van Amsterdam, No. 149.

Tijdens K., De Ruijter E. and De Ruijter J. (2014) 'Comparing work tasks of 160 occupations across eight European countries', *Employee Relations*, 36: 110-127.

Van der Velden R. and van Smoorenburg M. (1999) 'Overscholing en beloning: Het effect van verschillende meetmethoden', *Tijdschrift voor Arbeidsvraagstukken*, 15: 111–123.

Verdugo R. and Verdugo N. (1989) 'The impact of Surplus Schooling on Earnings', *Journal of Human Resources,* 24: 629-643.

Verhaest D. and Omey E. (2006) 'Measuring the incidence of over- and undereducation', *Quality & Quantity*, 40: 783-803.

Verhaest D. and Omey E. (2010) 'The determinants of overeducation: different measures, different outcomes?', *International Journal of Manpower*, 31: 608-625.

Verhaest D., Sellami S. and Van der Velden R. (2017) 'Differences in horizontal and vertical mismatches across countries and fields of study', *International Labour Review*, 156: 1-23.

Verhaest D., Van Trier W. and Sellami S. (2011) 'Welke factoren bepalen de aansluiting van onderwijs en beroep? Een onderzoek bij Vlaamse afgestudeerden uit het hoger onderwijs', *Tijdschrift voor Arbeidsvraagstukken*, 27: 416-436.

Witte J.C. and Kalleberg A.L. (1995) 'Matching Education and Jobs: The Fit Between Vocational Education and Employment in the German Labour Market', *European Sociological Review,* 11: 293-317.

Wolbers M. (2003) 'Job mismatches and their labour market effects among school-leavers in Europe', *European Sociological Review*, 19: 249-266.

Zhu Y. (2014) 'The impact of major–job mismatch on college graduates' early career earnings: evidence from China', *Education Economics*, 22: 511-528.